Part 23—Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes

This change incorporates Amendment 23–52, Powerplant Instruments; Fuel Pressure Indication, adopted March 21 and effective July 25, 1996. Section 23.1305(b)(4) is affected by this amendment.

In the preamble for Amendment 23–43, under *Benefits*, the ending of the last paragraph and the beginning of the paragraph under *Regulatory Flexibility Determination* were omitted. The appropriate pages are redone to correct this.

Bold brackets enclose the most recently changed or added material. The amendment number and effective date of new material appear in bold brackets at the end of each affected section.

Page Control Chart

Remove Pages	Dated	Insert Pages	Dated
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Suggest filing this transmittal at the beginning of the FAR. It will provide a method for determining that all changes have been received as listed in the current edition of AC 00–44, Status of Federal Aviation Regulations, and a check for determining if the FAR contains the proper pages.

detailed estimates of the economic consequences of this regulatory action. This summary and the full evaluation quantify, to the extent practicable, estimated costs to the private sector, consumers, Federal, State, and local governments, as well as anticipated benefits.

Executive Order 12291, dated February 17, 1981, directs Federal agencies to promulgate new regulations or modify existing regulations only if potential benefits to society for each regulatory change outweigh potential costs. The order also requires the preparation of a Regulatory Impact Analysis of all "major" rules except those responding to emergency situations or other narrowly defined exigencies. A "major" rule is one that is likely to result in an annual effect on the economy of $100 million or more, a major increase in consumer costs, or a significant adverse effect on competition.

The FAA has determined that this rule is not "major" as defined in the executive order; therefore, a full Regulatory Impact Analysis, which includes the identification and evaluation of cost-reducing alternatives to this rule, has not been prepared. Instead, the agency has prepared a more concise document termed a regulatory evaluation that analyzes only this rule without identifying alternatives. In addition to a summary of the regulatory evaluation, this section also contains the Regulatory Flexibility Determination required by the Regulatory Flexibility Act and an International Trade Impact Analysis. If more detailed economic information is desired, the reader may refer to the full regulatory evaluation contained in the docket.

Comments to the NPRM were received from eleven commenters. Three commenters addressed the economics of the proposed rule. One commenter, an aviation association, disagreed with the statement in the regulatory evaluation for the NPRM that, because of the depressed state of the general aviation industry, fewer designs are expected to appear on the market and this reduces the costs that industry must bear. The commenter advised that reduced numbers of new designs result in increased costs of each new design. Likewise, the cost of new models requiring compliance with some of the changed rules is higher and the cost of each airplane rises as the number of units falls. The FAA agrees with this position. The subject statement and its implications have been removed from the evaluation.

Another comment addressed the cost estimation for the proposed changes to §§23.1143 and 23.1147. These amendments require that the throttle and mixture controls, respectively, be designed so that if a control cable separates at the fuel metering device, the airplane will be capable of continued safe flight and landing. The commenter, an engine manufacturer, disagreed with the position expressed in the regulatory evaluation that the estimated $52,000 to $104,000 impact of these proposed changes would be small in relation to the total cost of designing a newly type certificated piston engine ($21 million). The commenter advised that these provisions would require the redesign and recertification of the fuel metering device of any existing certificated engine that would be installed in new airplanes designed after the effective date of the rule. As such, the commenter noted that the $52,000 to $104,000 design and certification cost would be an added cost necessary to continue production of a currently certificated engine for use in a new aircraft and, that under these circumstances, these costs would not be an insignificant consideration.

The FAA agrees with this comment and the regulatory evaluation for the final rule reflects this position. By placing these amendments in part 23 rather than part 33, currently approved engines that continue to be produced must have the safety features required by these two amendments if the engines are installed on newly certificated small airplanes.

A third commenter, also an aviation association, expressed general concern over the costs of making aviation safer and questioned whether the costs were justified by the results. Since no specific recommendation was expressed, no consequent changes have been made to the regulatory evaluation.

Economic Evaluation

Most of the amendments will impose negligible costs. A number of the provisions clarify the intent of current regulations and were requested by the manufacturers themselves. Other amendments in this give an accurate estimate of all the cost savings that can be achieved through regulatory harmonization, industry sources have estimated that savings of over $100 million can be achieved. Of the 77 airworthiness proposals retained in this final rule, 59 of them are fully harmonized with the JAA. In addition, several of the provisions that were not harmonized in this rule are scheduled for harmonization in later rulemaking.

Only two of the amendments in this final rule are expected to have costs that are not negligible. The amendment to § 23.1143 requires that, for reciprocating single-engine airplanes, each power or thrust control system must be designed so that if the control separates at the fuel metering device, the airplane will be capable of continued safe flight and landing. The amendment to § 23.1147 contains a parallel requirement for manual engine mixture controls.

As originally proposed, these amendments would have required a backup or other means to overcome a separation at any point in the control rather than specifically at the fuel metering device. The less restrictive requirements retained in the final rule result from concerns over the potential cost and technical feasibility of a mechanism with a spring force adequate to overcome a separation at any point in the control. As written, the amendments will not present a major design problem for manufacturers.

Costs

The design costs for § 23.1143 Engine Controls, and § 23.1147 Mixture Controls cannot be separated. The combined design and certification cost of these two requirements is estimated to range between $52,000 and $104,000 per engine model certificated for use in newly type certificated airplanes. This estimate is based on discussions with airplane engine manufacturers and the General Aviation Manufacturers Association. The expected hardware costs per engine will be minimal and are estimated to be $5.00 per individual engine for springs and fasteners.

The expected $52,000 to $104,000 design costs will be distributed over each engine that is sold. If these costs are distributed over 1,000 engines during a ten-year period, the attributable design cost per engine would range between $52 and $104. Lower or higher production schedules would have a proportional impact on the attributable unit costs. Using the midpoint of the range estimate, design and certification costs are expected to be $78 per engine. Combining this with the expected $5 hardware cost per airplane produces a total unit cost estimate of $83 per affected airplane.

Benefits

The expected benefit of these provisions is a reduction the risk of accidents related to throttle and fuel mixture control separations. According to data compiled by the National Transportation Safety Board (NTSB) for the years 1982 through 1987, there were 71 accidents in part 23 airplanes attributable to throttle and mixture control separations. These accidents resulted in 1 fatality, 10 serious injuries, and 31 minor injuries.

The subject amendments are in fact a result of NTSB recommendations to the Small Airplane Airworthiness Review Program. In support of its recommendations, the Board cited the fact that between 1964 and 1979 there were 148 reports of single-engine aircraft accidents initiated by throttle linkage failures, resulting in 5 deaths, 250 injuries, 15 destroyed aircraft, and 133 substantially damaged aircraft.

The NTSB further reported that from 1970 to 1981, at least 54 accidents occurred from engine failures or malfunctions that were caused by problems in the mixture control assembly. It was determined that the majority of these accidents were caused by a slippage or breakage of the mixture control linkage at the carburetor.

Taken together, these data show that throttle and mixture control separation is and has been a significant safety problem for single-engine airplanes. The expected reduction in accidents that will result from these standards can be examined on a rate basis.

As noted above, the expected unit cost of compliance for these amendments is $83 per affected airplane. By comparison, the FAA has determined that the average economic cost to society of a single

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small entities. The FAA has established criteria and guidelines for determining whether a rule has a significant economic impact on a substantial number of small entities. Based on these criteria, the threshold annualized cost constituting significant impact is $18,200 in 1992 dollars. The expected annual costs of this rule for any manufacturer will be well below the threshold. Accordingly, the FAA has determined that this rule will not have a significant economic impact on a substantial number of small entities.

International Trade Impact Assessment

The amendments in this rule will not constitute a barrier to international trade, including the export of American goods and services to foreign countries and the import of foreign goods and services into the United States. The small airplane airworthiness standards in this rule have been harmonized with those of foreign aviation authorities and will, in fact, lessen the restraints on trade.

Federalism Implications

The regulations herein will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this regulation will not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

Conclusion

The FAA is revising the airworthiness standards for normal, utility, acrobatic, and commuter category airplanes as a result of comments received in reply to the Small Airplane Airworthiness Review Program Notice No. 3 dated October 3, 1990. The notice, which addresses powerplant and equipment items, was published as a result of recommendations discussed at the Small Airplane Airworthiness Review Conference held on October 22–26, 1984, in St. Louis, Missouri. Originally, the proposals reflected updated safety standards and advancements in technology while reducing the regulatory burden for some requirements and maintaining an acceptable level of safety. Harmonization with the European JAA Joint Airworthiness Requirements became a dominant factor after the close of the reopened NPRM comment period on August 21, 1991. Considerable effort was invested to harmonize these airworthiness standards because aircraft industry estimates indicate reduced overall certification costs. These airworthiness standards will continue to provide adequate levels of safety for small airplanes used in both private and commercial operations.

For the reasons discussed in the preamble, and based on the findings in the Regulatory Flexibility Determination and the International Trade Impact Analysis, the FAA has determined that this regulation is not major under Executive Order 12291. In addition, the FAA certifies that this regulation will not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. This regulation is considered significant under DOT Regulatory Policies and Procedures (44 FR 11034; February 26, 1979). A regulatory evaluation of the regulation, including a Regulatory Flexibility Determination and International Trade Impact Analysis, has been placed in the docket. A copy may be obtained by contacting the person identified under "FOR FURTHER INFORMATION CONTACT."

The Amendment

Accordingly, the Federal Aviation Administration amends part 23 of the Federal Aviation Regulations (14 CFR part 23), effective May 10, 1993.

Authority: 49 U.S.C. 1344, 1354(a), 1355, 1421, 1423, 1425, 1428, 1429, and 1430; 49 U.S.C. 106(g).

***Corrected**

protection standards. These changes are needed to permit the design and type certification of higher performance airplanes with increased cruise speeds and better specific fuel consumption. The amendments are intended to achieve the benefits of certificating higher performance airplanes while affording their occupants the same level of protection in an emergency landing that is presently provided by airplanes with a 61-knot stall speed.

FOR FURTHER INFORMATION CONTACT: Mike Downs, Standards Office (ACE–112), Small Airplane Directorate, Aircraft Certification Service, Federal Aviation Administration, 601 East 12th Street, Kansas City, MO 64106; telephone (816) 426–6941.

SUPPLEMENTARY INFORMATION:

Background

This amendment is based on Notice of Proposed Rulemaking (NPRM) No. 91–12, which was published on May 13, 1991, (56 FR 22070). Comments to the NPRM were requested with a closing date of September 10, 1991. All comments received in response to Notice No. 91–12 have been considered in adopting this amendment.

Discussion of Comments

General

Ten commenters submitted responses to Notice No. 91–12. One commenter objects to a statement made by the FAA in the background material of the notice. Five commenters favor the proposal and four commenters oppose the proposal.

One commenter objects to a statement in the background material of the notice and indicates that the FAA erred in stating that airplanes with a V_{SO} less than 61 knots and high wing loading would require complex high lift systems that may result in a reduction of low speed flying qualities and lessen the level of safety of both normal and emergency operations in approach and landing conditions. The commenter adds that complex high lift devices have been around since the late 1920's and many of the devices used at that time maintained excellent control down to and through stall speeds lower than 40 mph. The FAA is aware of these devices and some of the airplanes on which they are installed. The use of these devices may result in a reduction of the low speed flying qualities of the airplane. The pilot of an airplane equipped with a more complex high lift system may choose to land at a higher speed in normal operation to reduce piloting tasks. Another pilot may choose to land at a higher speed in an emergency situation in order to ensure ground impact under controlled conditions. At a higher approach speed, an airplane is less responsive to gusts, and the control of the airplane about all three axes is improved. In short, the handling qualities of an airplane are also dependent on the type and design of the high lift devices, and on the controls employed and the skill required to operate them.

One commenter argues that the current 61-knot stall rule does not account for advancements made in airplane engine reliability. The commenter states that, due to the increased reliability of airplane engines, the 61-knot stall requirement should be deleted. Another commenter indicates that the excellent airplane engine reliability record cannot be improved, and that a change in stall speed is not warranted. The FAA agrees that even though the probability of a powerplant failure may decrease with increased powerplant reliability, the probability of an emergency forced landing condition may remain constant or be minimally affected. As pointed out by the Small Aircraft Stall Speed Study Group, the predominant cause of emergency forced landings is fuel starvation caused by poor management or handling of the fuel system by the pilot. Since increased powerplant reliability has little effect on the number of emergency forced landings, the occupants of airplanes having a stall speed greater than 61 knots must be afforded the benefits of the same structural crashworthiness as those occupants in airplanes having a stall speed of 61 knots.

to fuel pressure indicators to warn pilots of fuel system problems. A fuel pressure indicator is not technically the only means available to the pilot of indicating a fuel system problem. The amendment allows airplanes to be certificated with a means that indicates fuel flow or that monitors the fuel system and warns the pilot of any fuel flow trend that could lead to engine failure. New technology incorporated as a means of compliance with the revised rule could improve engine operation and reduce airplane operating costs.

FOR FURTHER INFORMATION CONTACT: J. Lowell Foster, Aerospace Engineer, Standards Office, Small Airplane Directorate, Aircraft Certification Service, Federal Aviation Administration, 601 East 12th Street, Kansas City, MO 64106; telephone (816) 426–5688.

SUPPLEMENTARY INFORMATION:

Background

Statement of the Problem

The FAA proposed to amend Title 14 of the Code of Federal Regulations (CFR), part 23, § 23.1305(b)(4), which required a fuel pressure indicator for each pump-fed engine. The pressure indicator gives continuous fuel pressure readings to the pilot. This information provides an advance warning of engine failure only when a pilot notices the pressure reading has deviated from the norm and when the pilot can diagnose what those deviations mean in terms of potential engine failure. The change would allow the options of a fuel pressure indicator, a fuel flow indicator, or a means that continuously monitors the fuel system and warns the pilot of any fuel flow trend that could cause engine failure. A fuel flow indicator would give continuous fuel flow readings to the pilot. Fuel flow information presents the fuel system status to the pilot in a manner similar to the fuel pressure indicator, but it also allows the pilot to quickly assess the engine's performance during critical phases of flight, such as takeoff. A continuous fuel system monitoring device would alert the pilot to any fuel flow trend that could lead to engine failure.

History

The Aircraft Owners and Pilots Association (AOPA) petitioned the FAA for new standards that would allow, on all pump-fed engines, a fuel flow system employing a differential pressure transducer to be accepted as a means of compliance equivalent to the current fuel pressure indicator requirements (55 FR 39299, September 26, 1990). The FAA requested that the Aviation Rulemaking Advisory Committee (ARAC) review the petition and recommend a course of action. In January 1992, the Fuel Pressure Indicators Working Group of the ARAC on General Aviation and Business Airplane Issues began a review of the AOPA's petition. As a result of the review, a Notice of Proposed Rulemaking (NPRM), Notice No. 94–37, was published on December 28, 1994 (59 FR 67114).

Discussion of Comments

General

This amendment is based on the NPRM, Notice No. 94–37, published December 28, 1994 (59 FR 67114). Interested persons were invited to participate in the development of this final rule by submitting written data, views, or arguments to the regulatory docket on or before February 27, 1995. Four comments were received on the proposal, including a letter of support from the Air Line Pilots Association.

The intent of the fuel pressure indicator requirement for pump-fed engines is to advise the pilot of a fuel pressure deficiency before total engine failure. The term "indicator" in § 23.1305(b)(4) implies that the fuel pressure be constantly displayed.

The FAA proposed a change to allow a fuel pressure indicator or a fuel flow indicator. The fuel flow indicator would constantly display information that the pilot could use to evaluate engine power, One commenter, a private individual, does not feel that § 23.1305(b)(4) should be changed as proposed. The commenter believes that ''an accurate indication is necessary for the pilot to have a situation awareness of his operating environment.'' The FAA understands and agrees with the overall basis for the comment; however, the FAA does not agree with all of the commenter's arguments and will address them individually.

First, the commenter believes the proposal implies that small airplane engines are ''antiquated'' using ''antiquated fuel flow means.'' The NPRM sections discussing the history of this rule focused on fuel pump reliability, radial engines, and diagnosing fuel pump failures, which were more frequent in the 1940's and 1950's than today. The FAA's intention in discussing the rule's history was to point out that the reliability of fuel pumps has improved since the 1940's. The FAA did not intend to imply that these engines were in some way ''antiquated.'' In fact, as the commenter points out, the basic engines used on most small airplanes are derivatives of the engines designed in the 1940's. Civil Air Regulation 3 airplanes, which constitute over 85 percent of the existing small airplanes flying today, have an excellent service history.

The commenter also points out that ''continual reference to automobile monitoring systems is well taken, except that automobiles can have a problem and pull off to the side of the road.'' Additionally, ''[a]utomobiles may have indicator lights and warnings as to the state of fuel consumption, but they also have a fuel quantity gauge so the driver can monitor the system in use to also determine an accurate fuel flow.'' The FAA used the reference to automobile technology to make the point that sophisticated engine monitoring is inexpensive enough to be mass produced for automobiles. Complex fuel monitoring systems are available in business jets and recently-certificated jet transport aircraft. This technology may soon be affordable to small airplane owners and manufacturers, and the FAA does not want to impede progress with rules offering no alternatives.

The commenter believes that the proposal would allow ''idiot lights.'' On the contrary, the FAA stated in the NPRM, ''A light that comes on at the same time that the engine quits is useless. A warning light system that would comply with this proposal would be sophisticated enough to read transients and trends, and would give a useful warning to the pilot.'' Also, the rule as proposed would require that any warning light system continuously monitor the fuel system and warn the pilot of any fuel flow trend that could lead to an engine failure.

Transport Canada questions the ability to show compliance with the requirement in § 23.1549 to identify maximum and, if applicable, minimum safe operating limits as well as the normal operating range of the instrument. This commenter points out that the typical fuel flow meter is a digital type, and it would be difficult for the applicant to provide equivalent markings. Engine manufacturers provide the information required by § 23.1549, which is then usually transcribed to the installed fuel pressure gauge. It appears that this information would not be presented through the use of typical digital fuel flow meters. The commenter offers the following suggestion: ''FAR 23.1549 was written with a traditional dial instrument in mind where the engine limitations could be easily displayed on the face of the unit and monitored by the crew. To allow flow meters or other fuel system monitors to satisfy the requirements of § 23.1549 where such a gauge no longer exists, compliance could be shown by (1) different colors to indicate changing trends in system performance (e.g., amber color for a low pressure/flow condition, red for impending engine failure), or (2) placarding, if appropriate, to indicate the normal and abnormal operating ranges.''

The FAA agrees with the commenter's suggestions as an acceptable means of compliance with § 23.1549. Suggested items (1) and (2) above offer the pilot a means to determine fuel flow limitations, which may be needed if a fuel flow meter is installed.

A commenter from Australia supports the proposal; however, the commenter feels that the proposed text would require a monitoring system that provides a warning of any trend that could lead to engine failure, which is an extremely difficult compliance requirement. The commenter further states: ''The historic

Section 23.1305 is adopted with the change in paragraph (b)(4)(ii) to add the words "fuel flow" before the word "trend."

International Compatibility

The agency has reviewed corresponding International Civil Aviation Organization international standards and recommended practices and Joint Aviation Authorities requirements for compatibility. The FAA has determined that this final rule, if adopted, would not present any differences.

Paperwork Reduction Act

In accordance with the Paperwork Reduction Act of 1990 (44 U.S.C. 3501 *et seq.*), there are no reporting or recordkeeping requirements associated with this rule.

Regulatory Evaluation Summary

Economic Evaluation, Regulatory Flexibility Determination, and Trade Impact Assessment

Proposed changes to federal regulations must undergo several economic analyses. First, Executive Order 12866 directs Federal agencies to promulgate new regulations or modify existing regulations only if the potential benefits to society outweigh the potential costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of regulatory changes on small entities. Finally, the Office of Management and Budget directs agencies to assess the effects of regulatory changes on international trade. In conducting these analyses, the FAA has determined that this rule: (1) will generate benefits exceeding its costs and is not significant as defined in Executive Order 12866; (2) is not significant as defined in DOT's Policies and Procedures; (3) will not have a significant economic impact on small entities; and (4) will not affect international trade. These analyses, available in the docket, are summarized below.

Economic Evaluation

The rule adopts a performance standard instead of requiring specific equipment. In this way, manufacturers can develop any design that monitors the fuel system and warns the pilot of any fuel flow trend that could lead to engine failure. The objective of imposing a performance standard could be met in this case by any means that "continuously indicates to the pilot fuel pressure or fuel flow, or that continuously monitors the fuel system and warns the pilot of any fuel flow trend that could lead to engine failure." This will maintain the level of safety intended by the original requirement, without imposing any additional costs. For example, a warning light system could possibly alert the pilot sooner than if the pilot relied on an instrument panel scan to notice a trend in the fuel pressure indication alone (as is currently the case).

A fuel flow indicator offers additional benefits compared to a fuel pressure indicator in that it enables the pilot to monitor the engine's fuel consumption and compare it to fuel consumption listed in the airplane flight manual. Consequently, engine operation could be improved, resulting in reduced fuel consumption and operating costs. In addition, continual fuel flow readings are useful during critical phases of flight, such as takeoff and climb. Thus, flight safety could be enhanced. The other alternative, a means to continuously monitor the fuel system, will also enhance safety by alerting the pilot to any fuel flow trend that could lead to engine failure.

Since the rule will permit but not require alternative means of warning pilots of fuel system problems, it is inherently cost-beneficial. To the extent that it encourages the future development and utilization of comprehensive engine control, monitoring, and diagnostic systems, it will generate benefits in the form of enhanced safety, improved fuel efficiency, power output, and engine life.

The rule will affect manufacturers of future part 23 airplanes. For manufacturers, Order 2100.14A defines a small entity as one with 75 or fewer employees and a significant economic impact as annualized costs of $19,000 or more. The FAA has determined that the rule will not have a significant economic impact on a substantial number of small manufacturers since the annualized certification costs of the rule are less than $19,000.

International Trade Impact Assessment

The rule will not constitute a barrier to international trade, including the export of U.S. airplanes and airplane parts to foreign markets or the import of foreign airplanes and airplane parts into the United States.

Federalism Implications

The regulations herein will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this regulation will not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

Conclusion

The FAA amends the airworthiness standards to allow airplane manufacturers to utilize new technology for fuel system monitoring to improve the operation and economy of part 23 airplanes powered by pump-fed engines. The current rule requires a fuel pressure indication; thus, it limits the means of compliance. The advances in engines monitoring systems and electronics offer technology that should be utilized by the aviation community. By broadening this airworthiness standard, fuel flow indicators or new fuel system monitors may provide better information to the pilot.

For the reasons discussed in the preamble, and based on the findings in the Regulatory Flexibility Determination and the International Trade Impact Analysis, the FAA has determined that this regulation is not significant under Executive Order 12866. In addition, the FAA certifies that this regulation will not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act. The regulation is not considered significant under DOT Regulatory Policies and Procedures (44 FR 11034; February 26, 1979). A regulatory evaluation of the regulation, including a Regulatory Flexibility Determination and Trade Impact Analysis, has been placed in the docket. A copy may be obtained by contacting the person identified under "FOR FURTHER INFORMATION CONTACT."

The Amendment

In consideration of the foregoing, the Federal Aviation Administration amends 14 CFR part 23 effective July 25, 1996.

The authority citation for part 23 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701–44702, 44704.

§ 23.1301 Function and Installation.

Each item of installed equipment must—

(a) Be of a kind and design appropriate to its intended function;

(b) Be labeled as to its identification, function, or operating limitations, or any applicable combination of these factors;

(c) Be installed according to limitations specified for that equipment; and

(d) Function properly when installed.

(Amdt. 23–7, Eff. 9/14/69); (Amdt. 23–14, Eff. 12/20/73); (Amdt. 23–20, Eff. 9/1/77)

§ 23.1303 Flight and navigation instruments.

The following are [the minimum] required flight and navigational instruments:

(a) An airspeed indicator.

(b) An altimeter.

(c) A direction indicator nonstabilized magnetic compass.

(d) For [reciprocating engine-powered airplanes of more than 6,000 pounds maximum weight and] turbine engine powered airplanes, a free air temperature indicator or an air-temperature indicator which provides indications that are convertible to free-air.

(e) A speed warning device for—

(1) Turbine engine powered airplanes; and

(2) Other airplanes for which V_{MO}/M_{MO} and V_D/M_D are established under §§ 23.335(b)(4) and 23.1505(c) if V_{MO}/M_{MO} is greater than 0.8 V_D/M_D.

The speed warning device must give effective aural warning (differing distinctively from aural warnings used for other purposes) to the pilots whenever the speed exceeds V_{MO} plus 6 knots or M_{MO} + 0.01. The upper limit of the production tolerance for the warning device may not exceed the prescribed warning speed. [The lower limit of the warning device must be set to minimize nuisance warning.]

instrument design must not provide any means, accessible to the flightcrew, of adjusting the relative positions of the attitude reference symbol and the horizon line beyond that necessary for parallax correction.

[(g) In addition, for commuter category airplanes:

[(1) If airspeed limitations vary with altitude, the airspeed indicator must have a maximum allowable airspeed indicator showing the variation of V_{MO} with altitude.

[(2) The altimeter must be a sensitive type.

[(3) Having a passenger seating configuration of 10 or more, excluding the pilot's seats and that are approved for IFR operations, a third attitude instrument must be provided that:

[(i) Is powered from a source independent of the electrical generating system;

[(ii) Continues reliable operation for a minimum of 30 minutes after total failure of the electrical generating system;

[(iii) Operates independently of any other attitude indicating system;

[(iv) Is operative without selection after total failure of the electrical generating system;

[(v) Is located on the instrument panel in a position acceptable to the Administrator that will make it plainly visible to and usable by any pilot at the pilot's station; and

[(vi) Is appropriately lighted during all phases of operation.]

(Amdt. 23–17, Eff. 2/1/77); (Amdt. 23–43, Eff. 5/10/93); [(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1305 Powerplant instruments.

The following are required powerplant instruments:

(a) *For all airplanes.*

(1) A fuel quantity indicator for each fuel tank, installed in accordance with § 23.1337(b).

(2) An oil pressure indicator for each engine.

(3) An oil temperature indicator for each engine.

(1) An induction system air temperature indicator for each engine equipped with a preheater and having induction air temperature limitations that can be exceeded with preheat.

(2) A tachometer indicator for each engine.

(3) A cylinder head temperature indicator for—

(i) Each air-cooled engine with cowl flaps;

(ii) Removed and reserved.

(iii) Each commuter category airplane.

(4) [For each pump-fed engine, a means:

[(i) That continuously indicates, to the pilot, the fuel pressure or fuel flow; or

[(ii) That continuously monitors the fuel system and warns the pilot of any fuel flow trend that could lead to engine failure.]

(5) A manifold pressure indicator for each altitude engine and for each engine with a controllable propeller.

(6) For each turbocharger installation:

(i) If limitations are established for either carburetor (or manifold) air inlet temperature or exhaust gas or turbocharger turbine inlet temperature, indicators must be furnished for each temperature for which the limitation is established unless it is shown that the limitation will not be exceeded in all intended operations.

(ii) If its oil system is separate from the engine oil system, oil pressure and oil temperature indicators must be provided.

(7) A coolant temperature indicator for each liquid-cooled engine.

(c) *For turbine engine-powered airplanes.* In addition to the powerplant instruments required by paragraph (a) of this section, the following powerplant instruments are required:

(1) A gas temperature indicator for each engine.

(2) A fuel flowmeter indicator for each engine.

(3) A fuel low pressure warning means for each engine.

tioning of the powerplant ice protection system for each engine.

(8) For each engine, an indicating means for the fuel strainer or filter required by § 23.997 to indicate the occurrence of contamination of the strainer or filter before it reaches the capacity established in accordance with § 23.997(d).

(9) For each engine, a warning means for the oil strainer or filter required by § 23.1019, if it has no bypass, to warn the pilot of the occurrence of contamination of the strainer or filter screen before it reaches the capacity established in accordance with § 23.1019(a)(5).

(10) An indicating means to indicate the functioning of any heater used to prevent ice clogging of fuel system components.

(d) *For turbojet/turbofan engine-powered airplanes.* In addition to the powerplant instruments required by paragraphs (a) and (c) of this section, the following powerplant instruments are required:

(1) For each engine, an indicator to indicate thrust or to indicate a parameter that can be related to thrust, including a free air temperature indicator if needed for this purpose.

(2) For each engine, a position indicating means to indicate to the flight crew when the thrust reverser, if installed, is in the reverse thrust position.

(e) *For turbopropeller-powered airplanes.* In addition to the powerplant instruments required by paragraphs (a) and (c) of this section, the following powerplant instruments are required:

(1) A torque indicator for each engine.

(2) A position indicating means to indicate to the flight crew when the propeller blade angle is below the flight low pitch position, for each propeller, unless it can be shown that such occurrence is highly improbable.

(Amdt. 23–7, Eff. 9/14/69); (Amdt. 23–14, Eff. 12/20/73); (Amdt. 23–15, Eff. 10/31/74); (Amdt. 23–18, Eff. 5/2/77); (Amdt. 23–26, Eff. 10/14/80); (Amdt. 23–34, Eff. 2/17/87); (Amdt. 23–43, Eff. 5/10/93); (Amdt. 23–51, Eff. 3/11/96); [(Amdt. 23–52, Eff. 7/25/96)]

12/1/78); (Amdt. 23–34, Eff. 2/17/87); (Amdt. 23–43, Eff. 5/10/93); [(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1309 Equipment, systems, and installations.

(a) Each item of equipment, each system, and each installation:

(1) When performing its intended function, may not adversely affect the response, operation, or accuracy of any—

(i) Equipment essential to safe operation; or

(ii) Other equipment unless there is a means to inform the pilot of the effect.

(2) In a single-engine airplane, must be designed to minimize hazards to the airplane in the event of a probable malfunction or failure.

(3) In a multiengine airplane, must be designed to prevent hazards to the airplane in the event of a probable malfunction or failure.

[(4) In a commuter category airplane, must be designed to safeguard against hazards to the airplane in the event of their malfunction or failure.]

(b) The design of each item of equipment, each system, and each installation must be examined separately and in relationship to other airplane systems and installations to determine if the airplane is dependent upon its function for continued safe flight and landing and, for airplanes not limited to VFR conditions, if failure of a system would significantly reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions. Each item of equipment, each system, and each installation identified by this examination as one upon which the airplane is dependent for proper functioning to ensure continued safe flight and landing, or whose failure would significantly reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions, must be designed to comply with the following additional requirements:

(1) It must perform its intended function under any foreseeable operating condition.

capability of the airplane or the ability of the crew to cope with adverse operating conditions must be improbable.

(3) Warning information must be provided to alert the crew to unsafe system operating conditions and to enable them to take appropriate corrective action. Systems, controls, and associated monitoring and warning means must be designed to minimize crew errors that could create additional hazards.

(4) Compliance with the requirements of paragraph (b)(2) of this section may be shown by analysis and, where necessary, by appropriate ground, flight, or simulator test. The analysis must consider—

(i) Possible modes of failure, including malfunctions and damage from external sources;

(ii) The probability of multiple failures, and the probability of undetected faults;

(iii) The resulting effects on the airplane and occupants, considering the stage of flight and operating conditions; and

(iv) The crew warning cues, corrective action required, and the crew's capability of determining faults.

(c) Each item of equipment, each system, and each installation whose functioning is required by this chapter and that requires a power supply is an "essential load" on the power supply. The power sources and the system must be able to supply the following power loads in probable operating combinations and for probable durations:

(1) Loads connected to the power distribution system with the system functioning normally.

(2) Essential loads after failure of—

(i) Any one engine on two-engine airplanes; or

(ii) Any two engines on an airplane with three or more engines; or

(iii) Any power converter or energy storage device.

(3) Essential loads for which an alternate source of power is required, as applicable, by the operating rules of this chapter, after any failure or malfunction in any one power supply sys-

more engines.

(e) In showing compliance with this section with regard to the electrical power system and to equipment design and installation, critical environmental and atmospheric conditions, including radio frequency energy and the effects (both direct and indirect) of lightning strikes, must be considered. For electrical generation, distribution, and utilization equipment required by or used in complying with this chapter, the ability to provide continuous, safe service under foreseeable environmental conditions may be shown by environmental tests, design analysis, or reference to previous comparable service experience on other airplanes.

(f) As used in this section, ''systems'' refers to all pneumatic systems, fluid systems, electrical systems, mechanical systems, and powerplant systems included in the airplane design, except for the following:

(1) Powerplant systems provided as part of the certificated engine.

(2) The flight structure (such as wing, empennage, control surfaces and their systems, the fuselage, engine mounting, and landing gear and their related primary attachments) whose requirements are specific in subparts C and D of this part.

(Amdt. 23–14, Eff. 12/20/73); (Amdt. 23–17, Eff. 2/1/77); (Amdt. 23–34, Eff. 2/17/87); (Amdt. 23–41, Eff. 11/26/90); [(Amdt. 23–49, Eff. 3/11/96)]

INSTRUMENTS: INSTALLATION

§ 23.1311 Electronic display instrument systems.

[(a) Electronic display indicators, including those with features that make isolation and independence between powerplant instrument systems impractical, must:

(1) Meet the arrangement and visibility requirements of § 23.1321.

(2) Be easily legible under all lighting conditions encountered in the cockpit, including direct sunlight, considering the expected electronic display brightness level at the end of an electronic display indicator's useful life. Specific limitations on display system useful life must be contained in the Instructions for Continued Airworthiness required by § 23.1529.

(3) Not inhibit the primary display of attitude, airspeed, altitude, or powerplant parameters needed by any pilot to set power within established limitations, in any normal mode of operation.

(4) Not inhibit the primary display of engine parameters needed by any pilot to properly set or monitor powerplant limitations during the engine starting mode of operation.

(5) Have an independent magnetic direction indicator and either an independent secondary mechanical altimeter, airspeed indicator, and attitude instrument or individual electronic display indicators for the altitude, airspeed, and attitude that are independent from the airplane's primary electrical power system. These secondary instruments may be installed in panel positions that are displaced from the primary positions specified by § 23.1321(d), but must be located where they meet the pilot's visibility requirements of § 23.1321(a).

(6) Incorporate sensory cues for the pilot that are equivalent to those in the instrument being replaced by the electronic display indicators.

(7) Incorporate visual displays of instrument markings, required by §§ 23.1541 through 23.1553, or visual displays that alert the pilot to abnormal operational values or approaches to established limitation values, for each parameter required to be displayed by this part.

[(b) The electronic display indicators, including their systems and installations, and considering other airplane systems, must be designed so that one display of information essential for continued safe flight and landing will remain available to the crew, without need for immediate action by any pilot for continued safe operation, after any single failure or probable combination of failures.

[(c) As used in this section, ''instrument'' includes devices that are physically contained in one unit, and devices that are composed of two or more physically separate units or components connected together (such as a remote indicating gyroscopic direction indicator that includes a magnetic sensing element, a gyroscopic unit, an amplifier, and an indicator connected together). As used in this section, ''primary'' display refers to the display of a parameter that is located in the instrument takeoff, initial climb, final approach, and landing must be located so that any pilot seated at the controls can monitor the airplane's flight path and these instruments with minimum head and eye movement. The powerplant instruments for these flight conditions are those needed to set power within powerplant limitations.

(b) For each multiengine airplane, identical powerplant instruments must be located so as to prevent confusion as to which engine each instrument relates.

(c) Instrument panel vibration may not damage, or impair the accuracy of, any instrument.

(d) [For each airplane, the flight instruments required by § 23.1303, and, as applicable, by the operating rules of this chapter, must be grouped on the instrument panel and centered as nearly as practicable about the vertical plane of each required pilot's forward vision. In addition:]

(1) The instrument that most effectively indicates the attitude must be on the panel in the top center position;

(2) The instrument that most effectively indicates airspeed must be adjacent to and directly to the left of the instrument in the top center position;

(3) The instrument that most effectively indicates altitude must be adjacent to and directly to the right of the instrument in the top center position;

(4) The instrument that most effectively indicates direction of flight, other than the magnetic direction indicator required by § 23.1303(c), must be adjacent to and directly below the instrument in the top center position; and

(5) Electronic display indicators may be used for compliance with paragraphs (d)(1) through (4) of this section when such displays comply with requirements in § 23.1311.

(e) If a visual indicator is provided to indicate malfunction of an instrument, it must be effective under all probable cockpit lighting conditions.

(Amdt. 23–14, Eff. 12/20/73); (Amdt. 23–20, Eff. 9/1/77); (Amdt. 23–41, Eff. 11/26/90); [(Amdt. 23–49, Eff. 3/11/96)]

(b) Amber, for caution lights (lights indicating the possible need for future corrective action);

(c) Green, for safe operation lights; and

(d) Any other color, including white, for lights not described in paragraphs (a) through (c) of this section, provided the color differs sufficiently from the colors prescribed in paragraphs (a) through (c) of this section to avoid possible confusion.

[(e) Effective under all probable cockpit lighting conditions.]

(Amdt. 23–17, Eff. 2/1/77); [(Amdt. 23–43, Eff. 5/10/93)]

§ 23.1323 Airspeed indicating system.

(a) Each airspeed indicating instrument must be calibrated to indicate true airspeed (at sea level with a standard atmosphere) with a minimum practicable instrument calibration error when the corresponding pitot and static pressures are applied.

(b) Each airspeed system must be calibrated in flight to determine the system error. The system error, including position error, but excluding the airspeed indicator instrument calibration error, may not exceed three percent of the calibrated airspeed or five knots, whichever is greater, throughout the following speed ranges:

(1) 1.3 V_{S1} to V_{MO}/M_{MO} or V_{NE}, whichever is appropriate with flaps retracted.

(2) 1.3 V_{S1} to V_{FE} with flaps extended.

[(c) The design and installation of each airspeed indicating system must provide positive drainage of moisture from the pitot static plumbing.]

([d]) If certification for instrument flight rules or flight in icing conditions is requested, each airspeed system must have a heated pitot tube or an equivalent means of preventing malfunction due to icing.

([e]) In addition, for commuter category airplanes, the airspeed indicating system must be calibrated to determine the system error [ ] during the accelerate-takeoff ground run. The ground run calibration must be obtained between 0.8 of the minimum value of V_1 and 1.2 times the maximum value of V_1, considering the approved ranges of altitude and weight. The ground run calibration

Eff. 2/4/91); [(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1325 Static pressure system.

(a) Each instrument provided with static pressure case connections must be so vented that the influence of airplane speed, the opening and closing of windows, airflow variations, moisture, or other foreign matter will least affect the accuracy of the instruments except as noted in paragraph (b)(3) of this section.

(b) If a static pressure system is necessary for the functioning of instruments, systems, or devices, it must comply with the provisions of paragraphs (b)(1) through (3) of this section.

(1) The design and installation of a static pressure system must be such that—

(i) Positive drainage of moisture is provided;

(ii) Chafing of the tubing, and excessive distortion or restriction at bends in the tubing, is avoided; and

(iii) The materials used are durable, suitable for the purpose intended, and protected against corrosion.

(2) A proof test must be conducted to demonstrate the integrity of the static pressure system in the following manner:

(i) *Unpressurized airplanes.* Evacuate the static pressure system to a pressure differential of approximately 1 inch of mercury or to a reading on the altimeter, 1,000 feet above the aircraft elevation at the time of the test. Without additional pumping for a period of 1 minute, the loss of indicated altitude must not exceed 100 feet on the altimeter.

(ii) *Pressurized airplanes.* Evacuate the static pressure system until a pressure differential equivalent to the maximum cabin pressure differential for which the airplane is type certificated is achieved. Without additional pumping for a period of 1 minute, the loss of indicated altitude must not exceed 2 percent of the equivalent altitude of the maximum cabin differential pressure or 100 feet, whichever is greater.

sure may be used in showing compliance with this requirement. If the reading of the altimeter, when on the alternate static pressure system differs from the reading of the altimeter when on the primary static system by more than 50 feet, a correction card must be provided for the alternate static system.

(c) Except as provided in paragraph (d) of this section, if the static pressure system incorporates both a primary and an alternate static pressure source, the means for selecting one or the other source must be designed so that—

(1) When either source is selected, the other is blocked off; and

(2) Both sources cannot be blocked off simultaneously.

(d) For unpressurized airplanes, paragraph (c)(1) of this section does not apply if it can be demonstrated that the static pressure system calibration, when either static source pressure is selected, is changed by the other static pressure source being open or blocked.

(e) [Each static pressure system must be calibrated in flight to determine the system error. The system error, in indicated pressure altitude, at sea-level, with a standard atmosphere, excluding instrument calibration error, may not exceed ±30 feet per 100 knot speed for the appropriate configuration in the speed range between 1.3 V_{SO} with flaps extended, and 1.8 V_{S1} with flaps retracted. However, the error need not be less than 30 feet.]*

(f) [Reserved]*

(g) For airplanes prohibited from flight in instrument meteorological [or icing] conditions, in accordance with § 23.1559(b) of this part, paragraph (b)(3) of this section does not apply.

(Amdt. 23–1, Eff. 7/29/65); (Amdt. 23–6, Eff. 8/1/67); (Amdt. 23–20, Eff. 9/1/77); (Amdt. 23–34, Eff. 2/17/87); (Amdt. 23–42, Eff. 2/4/91); [(Amdt. 23–49, Eff. 3/11/96)]; [*(Amdt. 23–50, Eff. 3/11/96)]

[§ 23.1326 Pitot heat indication systems.

[If a flight instrument pitot heating system is installed to meet the requirements specified in conditions exist:

[(1) The pitot heating system is switched "off."

[(2) The pitot heating system is switched "on" and any pitot tube heating element is inoperative.]

[(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1327 Magnetic direction indicator.

(a) Except as provided in paragraph (b) of this section—

(1) Each magnetic direction indicator must be installed so that its accuracy is not excessively affected by the airplane's vibration or magnetic fields; and

(2) The compensated installation may not have a deviation in level flight, greater than 10° on any heading.

(b) A magnetic nonstabilized direction indicator may deviate more than ten degrees due to the operation of electrically powered systems such as electrically heated windshields if either a magnetic stabilized direction indicator, which does not have a deviation in level flight greater than ten degrees on any heading, or a gyroscopic direction indicator, is installed. Deviations of a magnetic nonstabilized direction indicator of more than 10° must be placarded in accordance with § 23.1547(e).

(Amdt. 23–20, Eff. 9/1/77)

§ 23.1329 Automatic pilot system.

If an automatic pilot system is installed, it must meet the following:

(a) Each system must be designed so that the automatic pilot can—

(1) Be quickly and positively disengaged by the pilots to prevent it from interfering with their control of the airplane; or

(2) Be sufficiently overpowered by one pilot to let him control the airplane.

(b) If the provisions of paragraph (a)(1) of this section are applied, the quick release (emergency) control must be located on the control wheel (both control wheels if the airplane can be operated from

(d) Each manually operated control for the system operation must be readily accessible to the pilot. Each control must operate in the same plane and sense of motion as specified in § 23.779 for cockpit controls. The direction of motion must be plainly indicated on or near each control.

(e) Each system must be designed and adjusted so that, within the range of adjustment available to the pilot, it cannot produce hazardous loads on the airplane or create hazardous deviations in the flight path, under any flight condition appropriate to its use, either during normal operation or in the event of a malfunction, assuming that corrective action begins within a reasonable period of time.

(f) Each system must be designed so that a single malfunction will not produce a hardover signal in more than one control axis, if the automatic pilot integrates signals from auxiliary controls or furnishes signals for operation of other equipment, positive interlocks and sequencing of engagement to prevent improper operation are required.

(g) There must be protection against adverse interaction of integrated components, resulting from a malfunction.

(h) If the automatic pilot system can be coupled to airborne navigation equipment, means must be provided to indicate to the flight crew the current mode of operation. Selector switch position is not acceptable as a means of indication.

(Amdt. 23–23, Eff. 12/1/78); (Amdt. 23–43, Eff. 5/10/93); [(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1331 Instruments using a power [source.]

[For each instrument that uses a power source, the following apply:

(a) [Each instrument must have an integral visual power annunciator or separate power indicator to indicate when power is not adequate to sustain proper instrument performance. If a separate indicator is used, it must be located so that the pilot using the instruments can monitor the indicator with minimum head and eye movement. The power must be sensed at or near the point where it enters the instrument. For electric and vacuum/pressure instruments, the power is considered to be adequate ply of energy from any other source.

[(c) There must be at least two independent sources of power (not driven by the same engine on multiengine airplanes), and a manual or an automatic means to select each power source.]

[(Amdt. 23–43, Eff. 5/10/93)]

§ 23.1335 Flight director systems.

If a flight director system is installed, means must be provided to indicate to the flight crew its current mode of operation. Selector switch position is not acceptable as a means of indication.

(Amdt. 23–20, Eff. 9/1/77)

§ 23.1337 Powerplant instruments [installation.]

(a) *Instruments and instrument lines.*

(1) Each powerplant and auxiliary power unit instrument line must meet the requirements of § 23.993.

(2) Each line carrying flammable fluids under pressure must—

(i) Have restricting orifices or other safety devices at the source of pressure to prevent the escape of excessive fluid if the line fails; and

(ii) Be installed and located so that the escape of fluids would not create a hazard.

(3) Each powerplant and auxiliary power unit instrument that utilizes flammable fluids must be installed and located so that the escape of fluid would not create a hazard.

(b) [*Fuel quantity indication.* There must be a means to indicate to the flightcrew members the quantity of usable fuel in each tank during flight. An indicator calibrated in appropriate units and clearly marked to indicate those units must be used. In addition:]

(1) Each fuel quantity indicator must be calibrated to read ''zero'' during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply determined under [§ 23.959(a)]*;

gauge);]

([5]) Tanks with interconnected outlets and airspaces may be considered as one tank and need not have separate indicators; and

([6]) No fuel quantity indicator is required for an auxiliary tank that is used only to transfer fuel to other tanks if the relative size of the tank, the rate of fuel transfer, and operating instructions are adequate to—

(i) Guard against overflow; and

(ii) Give the flight crewmembers prompt warning if transfer is not proceeding as planned.

(c) *Fuel flowmeter system.* If a fuel flowmeter system is installed, each metering component must have a means to by-pass the fuel supply if malfunctioning of that component severely restricts fuel flow.

(d) *Oil quantity indicator.* There must be a means to indicate the quantity of oil in each tank—

(1) On the ground (such as by a stick gauge); and

(2) In flight, to the flight crewmembers, if there is an oil transfer system or a reserve oil supply system.

(e) [Deleted]

(Amdt. 23–7, Eff. 9/14/69); (Amdt. 23–18, Eff. 5/2/77); (Amdt. 23–43, Eff. 5/10/93); [(Amdt. 23–49, Eff. 3/11/96)]; [*(Amdt. 23–51, Eff. 3/11/96)]

ELECTRICAL SYSTEMS AND EQUIPMENT

§ 23.1351 General.

(a) *Electrical system capacity.* Each electrical system must be adequate for the intended use. In addition—

(1) Electric power sources, their transmission cables, and their associated control and protective devices, must be able to furnish the required power at the proper voltage to each load circuit essential for safe operation; and

(2) Compliance with paragraph (a)(1) of this section must be shown as follows—

in probable combinations and for probable durations.

(b) *Function.* For each electrical system, the following apply:

(1) Each system, when installed, must be—

(i) Free from hazards in itself, in its method of operation, and in its effects on other parts of the airplane;

(ii) Protected from fuel, oil, water, other detrimental substances, and mechanical damage; and

(iii) So designed that the risk of electrical shock to crew, passengers, and ground personnel is reduced to a minimum.

(2) [Electric power sources must function properly when connected in combination or independently.

(3) [No failure or malfunction of any electric power source may impair the ability of any remaining source to supply load circuits essential for safe operation.]

([4]) In addition, for commuter category airplanes, the following apply:

(i) Each system must be designed so that essential load circuits can be supplied in the event of reasonably probable faults or open circuits including faults in heavy current carrying cables;

(ii) A means must be accessible in flight to the flight crewmembers for the individual and collective disconnection of the electrical power sources from the system;

(iii) The system must be designed so that voltage and frequency, if applicable, at the terminals of all essential load equipment can be maintained within the limits for which the equipment is designed during any probable operating conditions;

(iv) If two independent sources of electrical power for particular equipment or systems are required, their electrical energy supply must be ensured by means such as duplicate electrical equipment, throwover switching, or multichannel or loop circuits separately routed; and

(1) Each generator/alternator must be able to deliver its continuous rated power, or such power as is limited by its regulation system.

(2) Generator/alternator voltage control equipment must be able to dependably regulate the generator/alternator output within rated limits;

(3) [Automatic means must be provided to prevent damage to any generator/alternator and adverse effects on the airplane electrical system due to reverse current. A means must also be provided to disconnect each generator/alternator from the battery and other generators/alternators.]

(4) There must be a means to give immediate warning to the flight crew of a failure of any generator/alternator.

(5) Each generator/alternator must have an overvoltage control designed and installed to prevent damage to the electrical system, or to equipment supplied by the electrical system that could result if that generator/alternator were to develop an overvoltage condition.

(d) *Instruments.* A means must exist to indicate to appropriate flight crewmembers the electric power system quantities essential for safe operation.

(1) For normal, utility, and acrobatic category airplanes with direct current systems, an ammeter that can be switched into each generator feeder may be used and, if only one generator exists, the ammeter may be in the battery feeder.

(2) For commuter category airplanes, the essential electric power system quantities include the voltage and current supplied by each generator.

(e) *Fire resistance.* Electrical equipment must be so designed and installed that in the event of a fire in the engine compartment, during which the surface of the firewall adjacent to the fire is heated to 2,000 °F for 5 minutes or to a lesser temperature substantiated by the applicant, the equipment essential to continued safe operation and located behind the firewall will function satisfactorily and each control and will not create an additional fire hazard.

(f) *External power.* If provisions are made for connecting external power to the airplane, and that external power can be electrically connected to power sources excluding the battery and any other standby electrical sources) inoperative, with critical type fuel (from the standpoint of flameout and restart capability), and with the airplane initially at the maximum certificated altitude. Parts of the electrical system may remain on if—

(1) A single malfunction, including a wire bundle or junction box fire, cannot result in loss of the part turned off and the part turned on; and

(2) The parts turned on are electrically and mechanically isolated from the parts turned off.

(Amdt. 23–7, Eff. 9/14/69); (Amdt. 23–14, Eff. 12/20/73); (Amdt. 23–17, Eff. 2/1/77); (Amdt. 23–20, Eff. 9/1/77); (Amdt. 23–34, Eff. 2/17/87); (Amdt. 23–43, Eff. 5/10/93); [(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1353 Storage battery design and installation.

(a) Each storage battery must be designed and installed as prescribed in this section.

(b) Safe cell temperatures and pressures must be maintained during any probable charging and discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge)—

(1) At maximum regulated voltage or power;

(2) During a flight of maximum duration; and

(3) Under the most adverse cooling condition likely to occur in service.

(c) Compliance with paragraph (b) of this section must be shown by tests unless experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.

(d) No explosive or toxic gases emitted by any battery in normal operation, or as the result of any probable malfunction in the charging system or battery installation, may accumulate in hazardous quantities within the airplane.

(e) No corrosive fluids or gases that may escape from the battery may damage surrounding structures or adjacent essential equipment.

unit must have—

(1) A system to control the charging rate of the battery automatically so as to prevent battery overheating;

(2) A battery temperature sensing and over-temperature warning system with a means for disconnecting the battery from its charging source in the event of an over-temperature condition; or

(3) A battery failure sensing and warning system with a means for disconnecting the battery from its charging source in the event of battery failure.

[(h) In the event of a complete loss of the primary electrical power generating system, the battery must be capable of providing at least 30 minutes of electrical power to those loads that are essential to continued safe flight and landing. The 30 minute time period includes the time needed for the pilots to recognize the loss of generated power and take appropriate load shedding action.]

(Amdt. 23–20, Eff. 9/1/77); (Amdt. 23–21, Eff. 3/1/78); [(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1357 Circuit protective devices.

(a) Protective devices, such as fuses or circuit breakers, must be installed in all electrical circuits other than—

(1) [Main circuits of starter motors used during starting only; and]

(2) Circuits in which no hazard is presented by their omission.

(b) A protective device for a circuit essential to flight safety may not be used to protect any other circuit.

(c) Each resettable circuit protective device (''trip free'' device in which the tripping mechanism cannot be overridden by the operating control) must be designed so that—

(1) A manual operation is required to restore service after tripping; and

(2) If an overload or circuit fault exists, the device will open the circuit regardless of the position of the operating control.

[(2) The spare fuse(s) must be readily accessible to any required pilot.]

(Amdt. 23–20, Eff. 9/1/77); [(Amdt. 23–43, Eff. 5/10/93)]

[§ 23.1359 Electrical system fire protection.

[(a) Each component of the electrical system must meet the applicable fire protection requirements of §§ 23.863 and 23.1182.

[(b) Electrical cables, terminals, and equipment in designated fire zones that are used during emergency procedures must be fire-resistant.

[(c) Insulation on electrical wire and electrical cable must be self-extinguishing when tested at an angle of 60 degrees in accordance with the applicable portions of Appendix F of this part, or other approved equivalent methods. The average burn length must not exceed 3 inches (76 mm) and the average flame time after removal of the flame source must not exceed 30 seconds. Drippings from the test specimen must not continue to flame for more than an average of 3 seconds after falling.]

[(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1361 Master switch arrangement.

(a) There must be a master switch arrangement to allow ready disconnection of each electric power source from power distribution systems, except as provided in paragraph (b) of this section. The point of disconnection must be adjacent to the sources controlled by the switch arrangement. If separate switches are incorporated into the master switch arrangement, a means must be provided for the switch arrangement to be operated by one hand with a single movement.

(b) Load circuits may be connected so that they remain energized when the master switch is open, if the circuits are isolated, or physically shielded, to prevent their igniting flammable fluids or vapors that might be liberated by the leakage or rupture of any flammable fluid system; and—

(1) The circuits are required for continued operation of the engine; or

and accessible to a crewmember.]

(Amdt. 23–20, Eff. 9/1/77); (Amdt. 23–43, Eff. 5/10/93); [(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1365 Electric cables and equipment.

(a) Each electric connecting cable must be of adequate capacity.

(b) [Any equipment that is associated with any electrical cable installation and that would overheat in the event of circuit overload or fault must be flame resistant. That equipment and the electrical cables must not emit dangerous quantities of toxic fumes.]

(c) Main power cables (including generator cables) in the fuselage must be designed to allow a reasonable degree of deformation and stretching without failure and must—

(1) Be separated from flammable fluid lines; or

(2) Be shrouded by means of electrically insulated flexible conduit, or equivalent, which is in addition to the normal cable insulation.

[(d) Means of identification must be provided for electrical cables, terminals, and connectors.

[(e) Electrical cables must be installed such that the risk of mechanical damage and/or damage caused by fluids vapors, or sources of heat, is minimized.

[(f) Where a cable cannot be protected by a circuit protection device or other overload protection, it must not cause a fire hazard under fault conditions.]

(Amdt. 23–14, Eff. 12/20/73); (Amdt. 23–43, Eff. 5/10/93); [(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1367 Switches.

Each switch must be—

(a) Able to carry its rated current;

(b) Constructed with enough distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting;

(c) Accessible to appropriate flight crewmembers; and

(a) Make each instrument and control easily readable and discernible;

(b) Be installed so that their direct rays, and rays reflected from the windshield or other surface, are shielded from the pilot's eyes; and

(c) Have enough distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting.

A cabin dome light is not an instrument light.

§ 23.1383 [Taxi and landing lights.

[Each taxi and landing light must be designed and installed so that:

[(a) No dangerous glare is visible to the pilots.

[(b) The pilot is not seriously affected by halation.

[(c) It provides enough light for night operations.

[(d) It does not cause a fire hazard in any configuration.]

[(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1385 Position light system installation.

(a) *General.* Each part of each position light system must meet the applicable requirements of this section and each system as a whole must meet the requirements of §§ 23.1387 through 23.1397.

(b) [*Left and right position lights.* Left and right position lights must consist of a red and a green light spaced laterally as far apart as practicable and installed on the airplane such that, with the airplane in the normal flying position, the red light is on the left side and the green light is on the right side.]

(c) [*Rear position light.* The rear position light must be a white light mounted as far aft as practicable on the tail or on each wing tip.]

[(d)] *Light covers and color filters.* Each light cover or color filter must be at least flame resistant and may not change color or shape or lose any appreciable light transmission during normal use.

(Amdt. 23–17, Eff. 2/1/77); [(Amdt. 23–43, Eff. 5/10/93)]

longitudinal axis of the airplane, and the other at 110° to the left of the first, as viewed when looking forward along the longitudinal axis.

(c) Dihedral angle *R* (right) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the airplane, and the other at 110° to the right of the first, as viewed when looking forward along the longitudinal axis.

(d) Dihedral angle *A* (aft) is formed by two intersecting vertical planes making angles of 70° to the right and to the left, respectively, to a vertical plane passing through the longitudinal axis, as viewed when looking aft along the longitudinal axis.

(e) If the rear position light, when mounted as far aft as practicable in accordance with § 23.1335(c), cannot show unbroken light within dihedral angle A (as defined in paragraph (d) of this section), a solid angle or angles of obstructed visibility totaling not more than 0.04 steradians is allowable within that dihedral angle, if such solid angle is within a cone whose apex is at the rear position light and whose elements make an angle of 30° with a vertical line passing through the rear position light.

(Amdt. 23–12, Eff. 11/5/71); [(Amdt. 23–43, Eff. 5/10/93)]

§ 23.1389 Position light distribution and intensities.

(a) *General.* The intensities prescribed in this section must be provided by new equipment with each light cover and color filter in place. Intensities must be determined with the light source operating at a steady value equal to the average luminous output of the source at the normal operating voltage of the airplane. The light distribution and intensity of each position light must meet the requirements of paragraph (b) of this section.

(b) [*Position lights.* The light distribution and intensities of position lights must be expressed in terms of minimum intensities in any vertical plane, and maximum intensities in overlapping beams, with dihedral angles *L, R,* and *A,* and must meet the following requirements:]

or exceed the appropriate value in § 23.1393, where *I* is the minimum intensity prescribed in § 23.1391 for the corresponding angles in the horizontal plane.

(3) *Intensities in overlaps between adjacent signals.* No intensity in any overlap between adjacent signals may exceed the values in § 23.1395, except that higher intensities in overlaps may be used with main beam intensities substantially greater than the minima specified, in §§ 23.1391 and 23.1393, if the overlap intensities in relation to the main beam intensities do not adversely affect signal clarity. When the peak intensity of the [left and right] position lights is more than 100 candles, the maximum overlap intensities between them may exceed the values in § 23.1395 if the overlap intensity in Area A is not more than 10 percent of peak position light intensity and the overlap intensity in Area B is not more than 2.5 percent of peak position light intensity.

(c) *Rear position light installation.* A single rear position light may be installed in a position displaced laterally from the plane of symmetry of an airplane if—

(1) The axis of the maximum cone of illumination is parallel to the flight path in level flight; and

(2) There is no obstruction aft of the light and between planes 70° to the right and left of the axis of maximum illumination.

[(Amdt. 23–43, Eff. 5/10/93)]

§ 23.1391 [Minimum intensities in the horizontal plane of position lights.]

Each position light intensity must equal or exceed the applicable values in the following table:

Dihedral angle (light included)	Angle from right or left of longitudinal axis, measured from dead ahead	Intensity (candles)
[*L* and *R* (red and green)].	0° to 10°	40
	10° to 20°	30
	20° to 110°	5
A (rear white)	110° to 180°	20

0°	1.00 *I.*
0° to 5°	0.90 *I.*
5° to 10°	0.80 *I.*
10° to 15°	0.70 *I.*
15° to 20°	0.50 *I.*
20° to 30°	0.30 *I.*
30° to 40°	0.10 *I.*
40° to 90°	0.05 *I.*

[(Amdt. 23–43, Eff. 5/10/93)]

§ 23.1395 [Maximum intensities in overlapping beams of position lights.]

No position light intensity may exceed the applicable values in the following table, except as provided in § 23.1389(b)(3):

Overlaps	Maximum intensity	
	Area A (candles)	Area B (candles)
Green in dihedral angle *L*	10	1
Red in dihedral angle *A*	10	1
Green in dihedral angle *A*	5	1
Red in dihedral angle *A*	5	1
Rear white in dihedral angle *L*	5	1
Rear white in dihedral angle *R*	5	1

where—

(a) Area A includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 10° but less than 20°; and

(b) Area B includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 20°.

[(Amdt. 23–43, Eff. 5/10/93)]

§ 23.1397 Color specifications.

Each position light color must have the applicable International Commission on Illumination chromaticity coordinates as follows:

(a) *Aviation red*—

"*y*" is not greater than 0.335; and

"*z*" is not greater than 0.002.

(b) *Aviation green*—

"0.636 − 0.400x";

Where "y^0" is the "y" coordinate of the Planckian radiator for the value of "x" considered.

(Amdt. 23–11, Eff. 8/11/71)

§ 23.1399 Riding light.

(a) Each riding (anchor) light required for a seaplane or amphibian, must be installed so that it can—

(1) Show a white light for at least two miles at night under clear atmospheric conditions; and

(2) Show the maximum unbroken light practicable when the airplane is moored or drifting on the water.

(b) Externally hung lights may be used.

§ 23.1401 Anticollision light system.

(a) *General.* [The airplane must have an anticollision light system that—]

(1) Consists of one or more approved anticollision lights located so that their light will not impair the flight crewmembers' vision or detract from the conspicuity of the position lights; and

(2) Meets the requirements of paragraphs (b) through (f) of this section.

(b) *Field of coverage.* The system must consist of enough lights to illuminate the vital areas around the airplane, considering the physical configuration and flight characteristics of the airplane. The field of coverage must extend in each direction within at least 75° above and 75° below the horizontal plane of the airplane, except that there may be solid angles of obstructed visibility totaling not more than 0.5 steradians.

(c) *Flashing characteristics.* The arrangement of the system, that is, the number of light sources, beam width, speed of rotation, and other characteristics, must give an effective flash frequency of not less than 40, nor more than 100, cycles per minute. The effective flash frequency is the frequency at which the airplane's complete anticollision light system is observed from a distance, and applies to each sector of light including any (if used) and expressed in terms of "effective" intensities, must meet the requirements of paragraph (f) of this section. The following relation must be assumed:

$$I_e = \frac{\int_{t_1}^{t_2} I(t)dt}{0.2 + (t_2 - t_1)}$$

where—

I_e = e ffective intensity (candles).
$I(t)$ = instantaneous intensity as a function of time.
$t_2 - t_1$ = flash time interval (seconds).

Normally, the maximum value of effective intensity is obtained when t_2 and t_1 are chosen so that the effective intensity is equal to the instantaneous intensity at t_2 and t_1.

(f) *Minimum effective intensities for anticollision lights.* Each anticollision light effective intensity must equal or exceed the applicable values in the following table.

Angle above or below the horizontal plane	Effective intensity (candles)
0° to 5°	400
5° to 10°	240
10° to 20°	80
20° to 30°	40
30° to 75°	20

(Amdt. 23–11, Eff. 8/11/71); (Amdt. 23–20, Eff. 9/1/77); [(Amdt. 23–49, Eff. 3/11/96)]

SAFETY EQUIPMENT

§ 23.1411 General.

(a) Required safety equipment to be used by the flight crew in an emergency, such as automatic liferaft releases, must be readily accessible.

(b) Stowage provisions for required safety equipment must be furnished and must—

(1) Be arranged so that the equipment is directly accessible and its location is obvious; and

(Amdt. 23–7, Eff. 9/14/69); (Amdt. 23–22, Eff. 12/4/78); (Amdt. 23–36, Eff. 9/14/88); [(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1415 Ditching equipment.

(a) Emergency flotation and signaling equipment required by any operating rule in this chapter must be installed so that it is readily available to the crew and passengers.

(b) Each raft and each life preserver must be approved.

(c) Each raft released automatically or by the pilot must be attached to the airplane by a line to keep it alongside the airplane. This line must be weak enough to break before submerging the empty raft to which it is attached.

(d) Each signaling device required by any operating rule in this chapter, must be accessible, function satisfactorily, and must be free of any hazard in its operation.

§ 23.1416 Pneumatic de-icer boot system.

If certification with ice protection provisions is desired and a pneumatic de-icer boot system is installed—

(a) The system must meet the requirements specified in § 23.1419.

(b) The system and its components must be designed to perform their intended function under any normal system operating temperature or pressure, and

(c) Means to indicate to the flight crew that the pneumatic de-icer boot system is receiving adequate pressure and is functioning normally must be provided.

(Amdt. 23–23, Eff. 12/1/78)

§ 23.1419 Ice protection.

[If certification with ice protection provisions is desired, compliance with the requirements of this section and other applicable sections of this part must be shown:

in this section, "Capable of operating safely," means that airplane performance, controllability, maneuverability, and stability must not be less than that required in part 23, subpart B.

(b) [Except as provided by paragraph (c) of this section, in addition to the analysis and physical evaluation prescribed in paragraph (a) of this section, the effectiveness of the ice protection system and its components must be shown by flight tests of the airplane or its components in measured natural atmospheric icing conditions and by one or more of the following tests, as found necessary to determine the adequacy of the ice protection system—

[(1) Laboratory dry air or simulated icing tests, or a combination of both, of the components or models of the components.

[(2) Flight dry air tests of the ice protection system as a whole, or its individual components.

[(3) Flight test of the airplane or its components in measured simulated icing conditions.

(c) [If certification with ice protection has been accomplished on prior type certificated airplanes whose designs include components that are thermodynamically and aerodynamically equivalent to those used on a new airplane design, certification of these equivalent components may be accomplished by reference to previously accomplished tests, required in § 23.1419(a) and (b), provided that the applicant accounts for any differences in installation of these components.

(d) [A means must be identified or provided for determining the formation of ice on the critical parts of the airplane. Adequate lighting must be provided for the use of this means during night operation. Also, when monitoring of the external surfaces of the airplane by the flight crew is required for operation of the ice protection equipment, external lighting must be provided that is adequate to enable the monitoring to be done at night. Any illumination that is used must be of a type that will not cause glare or reflection that would handicap crewmembers in the performance of their duties. The Airplane Flight Manual or other approved manual material must describe the means of determining ice formation and must contain

(a) In showing compliance with § 23.1309(b)(1) and (2) with respect to radio and electronic equipment and their installations, critical environmental conditions must be considered.

(b) Radio and electronic equipment, controls, and wiring must be installed so that operation of any unit or system of units will not adversely affect the simultaneous operation of any other radio or electronic unit, or system of units, required by this chapter.

[(c) For those airplanes required to have more than one flightcrew member, or whose operation will require more than one flightcrew member, the cockpit must be evaluated to determine if the flightcrew members, when seated at their duty station, can converse without difficulty under the actual cockpit noise conditions when the airplane is being operated. If the airplane design includes provision for the use of communication headsets, the evaluation must also consider conditions where headsets are being used. If the evaluation shows conditions under which it will be difficult to converse, an intercommunication system must be provided.

[(d) If installed communication equipment includes transmitter "off-on" switching, that switching means must be designed to return from the "transmit" to the "off" position when it is released and ensure that the transmitter will return to the off (non transmitting) state.

[(e) If provisions for the use of communication headsets are provided, it must be demonstrated that the flightcrew members will receive all aural warnings under the actual cockpit noise conditions when the airplane is being operated when any headset is being used.]

(Amdt. 23–43, Eff. 5/10/93); [(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1435 Hydraulic systems.

(a) *Design.* Each hydraulic system must be designed as follows:

(1) Each hydraulic system and its elements must withstand, without yielding, the structural loads expected in addition to hydraulic loads.

metric changes in all lines which are likely to remain closed long enough for such changes to occur.

(4) The minimum design burst pressure must be 2.5 times the operating pressure.

(b) *Tests.* Each system must be substantiated by proof pressure tests. When proof tested, no part of any system may fail, malfunction, or experience a permanent set. The proof load of each system must be at least 1.5 times the maximum operating pressure of that system.

(c) *Accumulators.* [A hydraulic accumulator or reservoir may be installed on the engine side of any firewall if—

(1) [It is an integral part of an engine or propeller system, or

(2) [The reservoir is nonpressurized and the total capacity of all such nonpressurized reservoirs is one quart or less.]

(Amdt. 23–7, Eff. 9/14/69); (Amdt. 23–14, Eff. 12/20/73); (Amdt. 23–43, Eff. 5/10/93); [(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1437 Accessories for multiengine airplanes.

For multiengine airplanes, engine-driven accessories essential to safe operation must be distributed among two or more engines so that the failure of any one engine will not impair safe operation through the malfunctioning of these accessories.

§ 23.1438 Pressurization and pneumatic systems.

(a) Pressurization system elements must be burst pressure tested to 2.0 times, and proof pressure tested to 1.5 times, the maximum normal operating pressure.

(b) Pneumatic system elements must be burst pressure tested to 3.0 times, and proof pressure tested to 1.5 times, the maximum normal operating pressure.

(c) An analysis, or a combination of analysis and test, may be substituted for any test required by paragraph (a) or (b) of this section if the is required to be used by the operating rules, oxygen equipment must meet the requirements of this section and §§ 23.1443 through 23.1449. Portable oxygen equipment may be used to meet the requirements of this part if the portable equipment is shown to comply with the applicable requirements, is identified in the airplane type design, and its stowage provisions are found to be in compliance with the requirements of § 23.561.]

(b) The oxygen system must be free from hazards in itself, in its method of operation, and its effect upon other components.

(c) There must be a means to allow the crew to readily determine, during the flight, the quantity of oxygen available in each source of supply.

(d) [Each required flight crewmember must be provided with—

[(1) Demand oxygen equipment if the airplane is to be certificated for operation above 25,000 feet.

[(2) Pressure demand oxygen equipment if the airplane is to be certificated for operation above 40,000 feet.

[(e) There must be a means, readily available to the crew in flight, to turn on and to shut off the oxygen supply at the high pressure source. This shutoff requirement does not apply to chemical oxygen generators.]

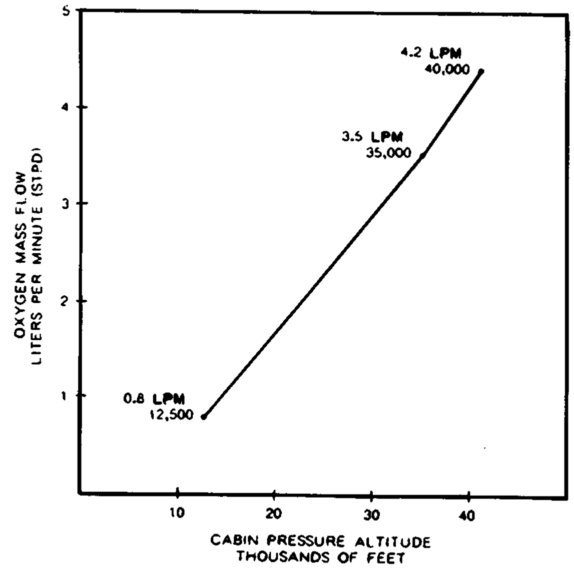
(Amdt. 23–9, Eff. 6/17/70); [(Amdt. 23–43, Eff. 5/10/93)]

§ 23.1443 Minimum mass flow of supplemental oxygen.

[(a) If continuous flow oxygen equipment is installed, an applicant must show compliance with the requirements of either paragraphs (a)(1) and (a)(2) or paragraph (a)(3) of this section:

[(1) For each passenger, the minimum mass flow of supplemental oxygen required at various cabin pressure altitudes may not be less than the flow required to maintain, during inspiration and while using the oxygen equipment (including masks) provided, the following mean tracheal oxygen partial pressures:

a mean tracheal oxygen partial pressure of 83.8mm Hg when breathing 30 liters per minute, BTPS, and with a tidal volume of 1,100cc with a constant time interval between respirations.



[(2) For each flight crewmember, the minimum mass flow may not be less than the flow required to maintain, during inspiration, a mean tracheal oxygen partial pressure of 149mm Hg when breathing 15 liters per minute, BTPS, and with a maximum tidal volume of 700cc with a constant time interval between respirations.

[(3) The minimum mass flow of supplemental oxygen supplied for each user must be at a rate not less than that shown in the following figure for each altitude up to and including the maximum operating altitude of the airplane.

[(b) If demand equipment is installed for use by flight crewmembers, the minimum mass flow of supplemental oxygen required for each flight crewmember may not be less than the flow required to maintain, during inspiration, a mean tracheal oxygen partial pressure of 122mm Hg up to and including a cabin pressure altitude of 35,000 feet, and 95 percent oxygen between cabin pressure altitudes of 35,000 and 40,000 feet, when breathing required is based upon an average flow rate of 3 liters per minute per person for whom first-aid oxygen is required.

[(d) As used in this section:

[(1) BTPS means Body Temperature, and Pressure, Saturated (which is, 37 °C, and the ambient pressure to which the body is exposed, minus 47mm Hg, which is the tracheal pressure displaced by water vapor pressure when the breathed air becomes saturated with water vapor at 37 °C).

[(2) STPD means Standard, Temperature, and Pressure, Dry (which is, 0 °C at 760mm Hg with no water vapor).]

(Amdt. 23–9, Eff. 6/17/70); [(Amdt. 23–43, Eff. 5/10/93)]

[§ 23.1445 Oxygen distribution system.

[(a) Except for flexible lines from oxygen outlets to the dispensing units, or where shown to be otherwise suitable to the installation, nonmetallic tubing must not be used for any oxygen line that is normally pressurized during flight.

[(b) Nonmetallic oxygen distribution lines must not be routed where they may be subjected to elevated temperatures, electrical arcing, and released flammable fluids that might result from any probable failure.]

[(Amdt. 23–43, Eff. 5/10/93)]

§ 23.1447 Equipment standards for oxygen dispensing units.

If oxygen dispensing units are installed, the following apply:

(a) There must be an individual dispensing unit for each occupant for whom supplemental oxygen is to be supplied. Each dispensing unit must:

(1) Provide for effective utilization of the oxygen being delivered to the unit.

(2) Be capable of being readily placed into position on the face of the user.

(3) Be equipped with a suitable means to retain the unit in position on the face.

(1) Cover the nose and mouth of the user; or

(2) Be a nasal cannula, in which case one oxygen dispensing unit covering both the nose and mouth of the user must be available. In addition, each nasal cannula or its connecting tubing must have permanently affixed—

(i) A visible warning against smoking while in use;

(ii) An illustration of the correct method of donning; and

(iii) A visible warning against use with nasal obstructions or head colds with resultant nasal congestion.

(c) If certification for operation above 18,000 feet (MSL) is requested, each oxygen dispensing unit must cover the nose and mouth of the user.

(d) [For a pressurized airplane designed to operate at flight altitudes above 25,000 feet (MSL), the dispensing units must meet the following:

[(1) The dispensing units for passengers must be connected to an oxygen supply terminal and be immediately available to each occupant wherever seated.

[(2) The dispensing units for crewmembers must be automatically presented to each crewmember before the cabin pressure altitude exceeds 15,000 feet, or the units must be of the quick-donning type, connected to an oxygen supply terminal that is immediately available to crewmembers at their station.

(e) [If certification for operation above 30,000 feet is requested, the dispensing units for passengers must be automatically presented to each occupant before the cabin pressure altitude exceeds 15,000 feet.]

(f) If an automatic dispensing unit (hose and mask, or other unit) system is installed, the crew must be provided with a manual means to make the dispensing units immediately available in the event of failure of the automatic system.

(Amdt. 23–9, Eff. 6/17/70); (Amdt. 23–20, Eff. 9/1/77); (Amdt. 23–30, Eff. 3/29/84); (Amdt. 23–43, Eff. 5/10/93); [(Amdt. 23–49, Eff. 3/11/96)]

(a) For the purpose of this section, a chemical oxygen generator is defined as a device which produces oxygen by chemical reaction.

(b) Each chemical oxygen generator must be designed and installed in accordance with the following requirements:

(1) Surface temperature developed by the generator during operation may not create a hazard to the airplane or to its occupants.

(2) Means must be provided to relieve any internal pressure that may be hazardous.

(c) In addition to meeting the requirements in paragraph (b) of this section, each portable chemical oxygen generator that is capable of sustained operation by successive replacement of a generator element must be placarded to show—

(1) The rate of oxygen flow, in liters per minute;

(2) The duration of oxygen flow, in minutes, for the replaceable generator element; and

(3) A warning that the replaceable generator element may be hot, unless the element construction is such that the surface temperature cannot exceed 100 °F.

(Amdt. 23–20, Eff. 9/1/77)

[§ 23.1451 Fire protection for oxygen equipment.

[Oxygen equipment and lines must:

[(a) Not be installed in any designated fire zones.

[(b) Be protected from heat that may be generated in, or escape from, any designated fire zone.

[(c) Be installed so that escaping oxygen cannot come in contact with and cause ignition of grease, fluid, or vapor accumulations that are present in normal operation or that may result from the failure or malfunction of any other system.]

[(Amdt. 23–49, Eff. 3/11/96)]

[§ 23.1453 Protection of oxygen equipment from rupture.

[(a) Each element of the oxygen system must have sufficient strength to withstand the maximum

of rupture in a crash landing are minimized.]

[(Amdt. 23–49, Eff. 3/11/96)]

§ 23.1457 Cockpit voice recorders.

(a) Each cockpit voice recorder required by the operating rules of this chapter must be approved and must be installed so that it will record the following:

(1) Voice communications transmitted from or received in the airplane by radio.

(2) Voice communications of flight crewmembers on the flight deck.

(3) Voice communications of flight crewmembers on the flight deck, using the airplane's interphone system.

(4) Voice or audio signals identifying navigation or approach aids introduced into a headset or speaker.

(5) Voice communications of flight crewmembers using the passenger loudspeaker system, if there is such a system and if the fourth channel is available in accordance with the requirements of paragraph (c)(4)(ii) of this section.

(b) The recording requirements of paragraph (a)(2) of this section must be met by installing a cockpit-mounted area microphone, located in the best position for recording voice communications originating at the first and second pilot stations and voice communications of other crewmembers on the flight deck when directed to those stations. The microphone must be so located and, if necessary, the preamplifiers and filters of the recorder must be so adjusted or supplemented, so that the intelligibility of the recorded communications is as high as practicable when recorded under flight cockpit noise conditions and played back. Repeated aural or visual playback of the record may be used in evaluating intelligibility.

(c) Each cockpit voice recorder must be installed so that the part of the communication or audio signals specified in paragraph (a) of this section obtained from each of the following sources is recorded or, a separate channel:

(i) Each boom, mask, or handheld microphone, headset, or speaker used at the station for the third and fourth crewmembers.

(ii) If the stations specified in paragraph (c)(4)(i) of this section are not required or if the signal at such a station is picked up by another channel, each microphone on the flight deck that is used with the passenger loudspeaker system, if its signals are not picked up by another channel.

(5) And that as far as is practicable all sounds received by the microphone listed in paragraphs (c)(1), (2), and (4) of this section must be recorded without interruption irrespective of the position of the interphone-transmitter key switch. The design shall ensure that sidetone for the flight crew is produced only when the interphone, public address system, or radio transmitters are in use.

(d) Each cockpit voice recorder must be installed so that—

(1) It receives its electric power from the bus that provides the maximum reliability for operation of the cockpit voice recorder without jeopardizing service to essential or emergency loads.

(2) There is an automatic means to simultaneously stop the recorder and prevent each erasure feature from functioning, within 10 minutes after crash impact; and

(3) There is an aural or visual means for preflight checking of the recorder for proper operation.

(e) The record container must be located and mounted to minimize the probability of rupture of the container as a result of crash impact and consequent heat damage to the record from fire. In meeting this requirement, the record container must be as far aft as practicable, but may not be where aft mounted engines may crush the container during impact. However, it need not be outside of the pressurized compartment.

(f) If the cockpit voice recorder has a bulk erasure device, the installation must be designed to minimize the probability of inadvertent operations and actuation of the device during crash impact.

(Amdt. 23–35, Eff. 10/11/88)

§ 23.1459 Flight recorders.

(a) Each flight recorder required by the operating rules of this chapter must be installed so that—

(1) It is supplied with airspeed, altitude, and directional data obtained from sources that meet the accuracy requirements of §§ 23.1323, 23.1325, and 23.1327, as appropriate;

(2) The vertical acceleration sensor is rigidly attached, and located longitudinally either within the approved center of gravity limits of the airplane, or at a distance forward or aft of these limits that does not exceed 25 percent of the airplane's mean aerodynamic chord;

(3) It receives its electrical power from the bus that provides the maximum reliability for operation of the flight recorder without jeopardizing service to essential or emergency loads;

(4) There is an aural or visual means for preflight checking of the recorder for proper recording of data in the storage medium.

(5) Except for recorders powered solely by the engine-driven electrical generator system, there is an automatic means to simultaneously stop a recorder that has a data erasure feature and prevent each erasure feature from functioning, within 10 minutes after crash impact; and

(b) Each nonejectable record container must be located and mounted so as to minimize the probability of container rupture resulting from crash impact and subsequent damage to the record from fire. In meeting this requirement the record container must be located as far aft as practicable, but need not be aft of the pressurized compartment, and may not be where aft-mounted engines may crush the container upon impact.

(c) A correlation must be established between the flight recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments. The correlation must cover the airspeed range over which the airplane is to be operated, the range of altitude to which the airplane is limin such a manner that they are not likely to be separated during crash impact.

(e) Any novel or unique design or operational characteristics of the aircraft shall be evaluated to determine if any dedicated parameters must be recorded on flight recorders in addition to or in place of existing requirements.

(Amdt. 23–35, Eff. 10/11/88)

§ 23.1461 Equipment containing high energy rotors.

(a) [Equipment, such as Auxiliary Power Units (APU) and constant speed drive units, containing

(2) Equipment control devices, systems, and instrumentation must reasonably ensure that no operating limitations affecting the integrity of high energy rotors will be exceeded in service.

(c) It must be shown by test that equipment containing high energy rotors can contain any failure of a high energy rotor that occurs at the highest speed obtainable with the normal speed control devices inoperative.

(d) Equipment containing high energy rotors must be located where rotor failure will neither endanger the occupants nor adversely affect continued safe flight.

(Amdt. 23–20, Eff. 9/1/77); [(Amdt. 23–49, Eff. 3/11/96)]